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CONTACT AERATION WASTEWATER TREATMENT PLANT UPGRADING EVALUATION REESE AIR FORCE BASE, TEXAS

NOVEMBER 1979

USAF Occupational and Environmental Health Laboratory
Aerospace Medical Division (AFSC)
Brooks Air Force Base, Texas 78235

NOTICES

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Commander

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A 1940 vintage contact aeration wastewater treatment (Hays Process) plant at Reese AFB TX was upgraded by replacing the original plain asbestos plate media with honeycombed plastic media to increase the contact surface area. The old, partially clogged air diffusers were also replaced with new ones. A literature review regarding the history, advantages and disadvantages, and design criteria of contact aeration process is presented. The performance efficiencies of the Reese AFB contact aeration treatment plant before and after upgrading are presented and compared with the NRC Equation for the

Item 20.

contact aeration process. It was found that the performance efficiencies of the Reese AFB treatment plant are better than what the NRC Equation predicted both before and after the upgrading. The treatment efficiencies after upgrading are 95 percent BOD_5 removal, 97 percent for SS removal, and about 50 percent for nitrification. This kind of performance is better than the other conventional secondary treatment systems, such as activated sludge and trickling filter systems, under comparable design criteria. The contact aeration system is also easier to operate because there is no need for recirculation or sludge return.

Report No. 79-166

CONTACT AERATION WASTEWATER TREATMENT
PLANT UPGRADING EVALUATION
REESE AIR FORCE BASE, TEXAS

NOVEMBER 1979

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I. INTRODUCTION

An on-site evaluation of the Reese AFB TX Wastewater Reclamation Facilities was requested by HQ ATC/SGPAP on 9 April 1979. The survey was approved by HQ AFSC/SGP on 4 May 1979. The survey was requested as a result of the modification of the 1940 vintage asbestos plate contact aeration process (Hays Process) package treatment plant at Reese AFB. The modifications to the treatment plant included the replacement of the asbestos plates with honeycombed plastic media and the replacement of the air diffuser systems in the aeration tanks. Since the application of honeycombed plastic media in the Hays Process is unusual, a study of the operational efficiency and performance characteristics will provide significant "lessons learned" on upgrading and modifying treatment plants.

During the period 5-6 June 1979, a representative of the USAF OEHL visited Reese AFB to evaluate the existing conditions at the wastewater treatment plant and to make preliminary arrangements for a full-scale field survey.

A dye test was performed at the two aeration tanks for a hydraulic distribution test. The results indicated that the flow distribution through the honeycombed plastic media was quite even. Grab samples were also taken at various points of the treatment facilities for the analysis of nitrogen and other parameters such as COD, phenol and heavy metals. A biweekly sampling program was also arranged, for the same analyses, to check the progression of nitrifying capability in this two-stage aeration system.

A technical report titled, "Engineering and Biological Evaluation of Wastewater Treatment Practices at Reese AFB TX"[1], was written by the USAF Environmental Health Laboratory, Kelly AFB, Texas, in April 1976. That report is basically a summary report of the field survey results from January 1972-October 1975 at Reese AFB, including domestic wastewater treatment, industrial wastewater, and bacteriological, plankton, macroinvertebrate, animal data and observations in the polishing lagoons and the irrigation lake.

This survey, however, was primarily concentrated on the evaluation of the upgrading of the contact aeration process by replacing the original asbestos plate media with honeycomb plastic media.

II. METHODS

A. Project Personnel

1. USAF OEHL

Mr Ching-San Huang - Project Director
SSgt Gene D. Jenkins - Laboratory Technician
SSgt Walter A. Eichin - Laboratory Technician
Mr Mark A. Willis - Laboratory Technician

2. Reese AFB

Capt Thoma. J. Walker - Chief, Bioenvironmental Engineering
Lt Col Richard Holcomb - Base Civil Engineer
Mr Frank Falbo - Deputy Base Civil Engineer
Mr Virgel Gatlin - Sewage Treatment Plant Superintendant
A1C Cathy R. Cox - NCOIC, Bioenvironmental Engineering
Sgt Charles Baldwin - NCOIC, Environmental Support Branch
Amn Vicki L. Smith - Bioenvironmental Engineer Technician
Amn Michelle R. Durepos - Bioenvironmental Engineer Technician

B. Field Survey

The performance of the wastewater treatment facilities at Reese AFB was evaluated in the following manner:

Six sampling stations were established in the wastewater treatment facilities as shown in Table 1 and in Figure 1. Figure 1 is a schematic flow diagram of the treatment plant.

Table 1: Description of Sampling Sites

Site No.	Location/Description
1	Influent after barminutor
2	Effluent from Primary Clarifier
3	Effluent from Intermediate Clarifier
4	Effluent from Final Clarifier
5	Effluent from Polishing Lagoon
6	Playa Lake at Irrigation Intake

A dissolved oxygen (D.O.) meter was installed, both at the outlet of the first aeration tank and at the outlet of the second aeration tank, to monitor the D.O. level in the wastewater.

Since there is no flow meter in the treatment facilities, a Manning Environmental Corporation Flow Meter, Model 3000-A was installed at the V-notch weir at the chlorination tank outlet to estimate the daily flow rate in the treatment plant.

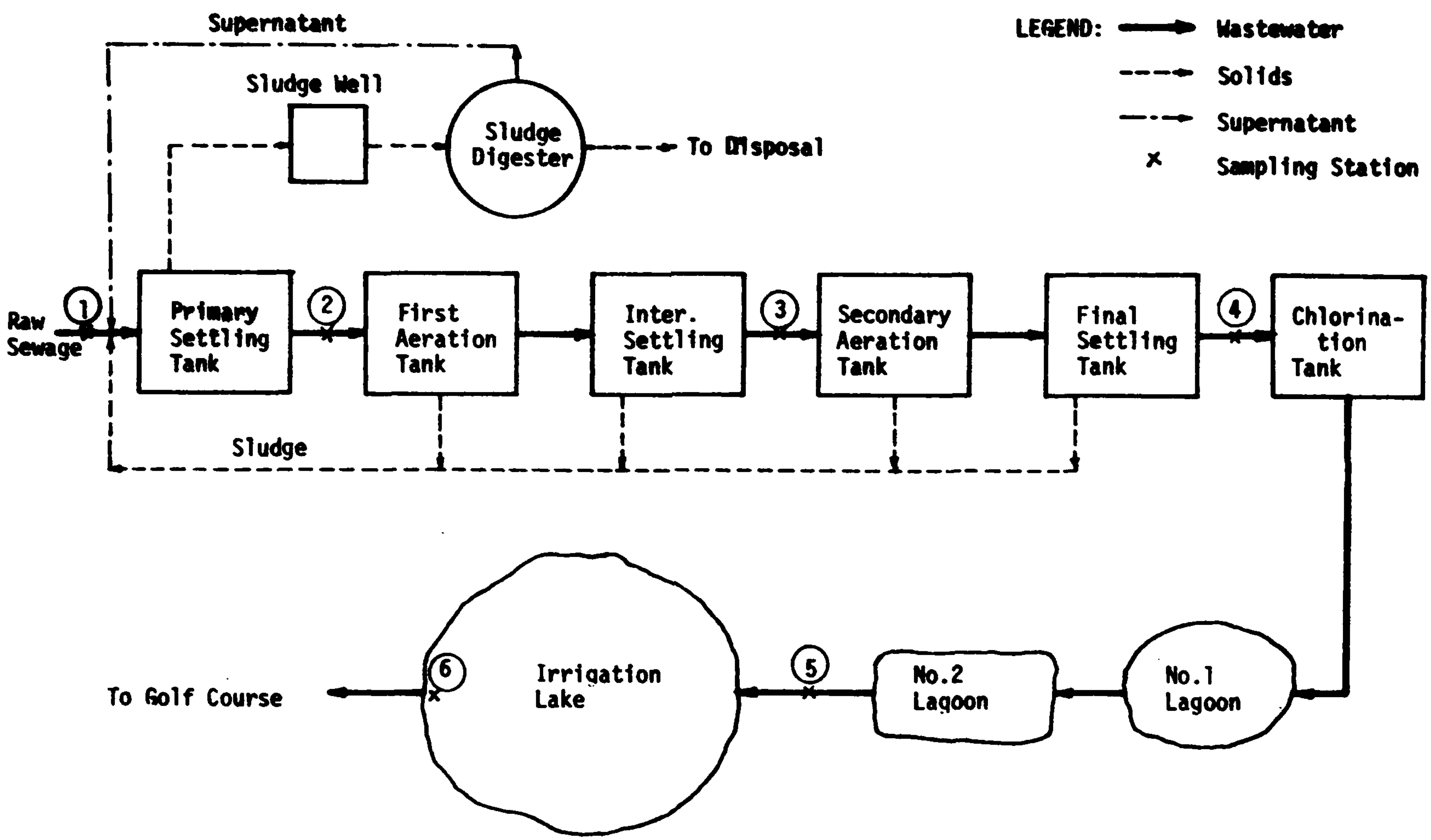

FIGURE 1. SCHEMATIC FLOW DIAGRAM AND SAMPLING STATIONS AT REESE AFB STP

The pH of the wastewater was checked occasionally.

C. Analytical Procedures

All of the analytical procedures were performed in accordance with the Standard Methods for the Examination of Water and Wastewater, 14th Ed.

D. Quality Control

Quality control samples were obtained from the US Environmental Protection Agency (EPA) for BOD_5, COD and NO_3-N tests. All of the results for the quality control samples came within acceptable ranges for laboratory determinations.

III. LITERATURE REVIEW OF CONTACT AERATION PROCESS OR HAYS PROCESS

A. History of Contact Aeration Process

"Contact aerators" were contact beds that were continuously submerged in the wastewater they treated. Contact materials included stone, coke, laths, movable pieces of cork or wood, and corrugated sheets of aluminum, artificial stone or ceramic materials of special shapes. They were once used as colloiders by Travis, who placed laths in the sedimentation chamber on 6-inch to 9-inch centers as the contact surfaces. The limited success of the Travis "colloiders", as his devices were called, was primarily due firstly, to the small amount of surface afforded by these "colloiders"; secondly, the lack of any provision for the removal of the precipitated material from the contact surfaces; and thirdly, failure to maintain aerobic conditions.

In 1929, Buswell and Pearson suggested a "Nidus Tank" arrangement which was constructed to allow for the contact surface treatment in two stages separated by intermediate sedimentation.[2] The contact surface was provided by mats woven from veneer or basket strips and placed vertically in the aeration tank. Compressed air was introduced through perforated pipes placed underneath the "Nidus (Nest)" racks.

Between 1930-1938, Clyde C. Hays, City Chemist of Waco, Texas, developed a new flow diagram and patented the contact aeration process as the "Hays Process".[3] Further mechanical improvements were incorporated into the process by Llewellyn B. Griffith of Washington, D.C., who was associated with Hays in the early stages of development. Therefore, in some areas, it is known as the Griffith Process.[4,5]

The first municipal contact aeration plant in the U.S. was constructed at Elgin, Texas in 1939.[3] This plant utilized rock as the contact media. Early plants made use of aerated submerged rock filters called "Hays Process Filters," and the plants were often referred to as the "Submerged Contact Aeration Process." These plants were comprised of preliminary settling tanks, first-stage submerged rock filter, intermediate settling tanks, second-stage submerged rock filters, and final settling tanks. Preaeration tanks without contact surfaces were used under exceptional conditions, such as strong industrial waste treatment.

Within the next few years many improvements were effected. One of the most important of these was propounded by H.B. Schuehoff,[4] who proposed the use of a series of flat asbestos panels in place of the rock medium formerly used in the submerged filters. These contact surfaces were of 1/4 in, 4 ft by 8 ft asbestos-cement plates placed on 1 1/2 in centers.[5,6] The top of the plates were submerged about 4 in. The aeration tank side water depth was about 9.5 ft with a cone shaped bottom for the collection of sludge.

Over 70 Hays Process installations were in operation by 1943, including about 50 Army installations and a few Navy installations.[3,5]

According to the Subcommittee of the Committee on Sanitary Engineering, National Research Council (NRC)[6], the contact aeration plants could obtain 80 to 95 percent BOD removal under favorable conditions of loading and sewage concentration. However, when strong stale sewage had to be treated, or where difficulties developed in the aeration system originally installed, effluents were unsatisfactory, odors became intense, and "first-aid" measures had to be

applied in order to keep the plants in service. The difficulties of operation of contact aerators, high maintenance labor requirements, and more than occasional odor nuisances indicated that contact aerators were less desirable for use in military camps than were trickling filters, as suggested by the NRC.[6] For this reason, the contact aerators used by the military were gradually phased out and replaced by trickling filter or activated sludge treatment plants.

In the 1950s, however, the contact aeration process made a resurgence in New Jersey. Prior to 1951, there were no contact aeration system installations in the State of New Jersey. In 1957, there were 27 contact aeration plants in operation in New Jersey and four others under construction.[4] The evaluation of these plants by Wilford and Conlon[4] indicated that the contact aeration process was fundamentally sound. It was capable of efficient sewage treatment and, with correct design parameters and diligent operation, it could accomplish better than 90 percent removal of both suspended solids and BOD_5.

In 1967, a so-called "Fixed Activated Sludge Process" was studied.[7] This system was actually a contact aeration system, but used plastic net panels as the contact surface. According to this study, this process could treat petrochemical wastes and soft drink bottling-waste efficiently.

There was a recent study in the application of contact aeration system in biological nitrification.[8] The study used two adjacent contact aeration plants: one plant was constructed in 1965 and had 0.3 MGD capacity, and the other plant was constructed in 1973 and had 0.8 MGD design capacity. Portions (about 0.2 MGD) of the final effluent from the 0.8 MGD plant were pumped into the first aeration unit of the 0.3 MGD plant. The results indicate that a removal of up to 0.8 lb NH_3-N/1000 sq ft/day, or an effluent ammonia nitrogen concentration of 0.1 - 0.5 mg/ℓ, could be achieved.

B. Advantages and Disadvantages

The contact aeration process incorporates the features of both trickling filters and activated sludge units. The contact aeration system, therefore, possesses some of the advantages and disadvantages of both the trickling filter system and the activated sludge system:

1. No sludge return or recirculation is required in the contact aeration system so that the power consumption is lower than both the trickling filter and the activated sludge systems.

2. Compressed air is required for contact aeration system but the air requirement is much less than for the activated sludge system; however, there is no requirement for the trickling filter system.

3. Like the trickling filter, the contact aeration system has fixed biological film characteristics and can sustain wider pH and temperature fluctuations than the activated sludge system.

4. The operation and the maintenance of the contact aeration system is simpler than the activated sludge system, but not as simple as the trickling filter system.

5. The operation of the contact aeration system is not as flexible as the activated sludge system so that the treatment efficiency is reduced if the waste loading fluctuates very much from time to time.

6. The contact aeration system has a more positive oxygen supply method, and there is no flow distribution problem in the media as is sometimes encountered in the trickling filter system. Therefore, the treatment efficiency in the contact aeration system can be achieved more consistently, if not better, than the trickling filter system.

C. Design Criteria

The design criteria of the contact aeration process are as follows according to Steel:[5]

1. Settling Tanks

Settling Tank	Detention Time (hr)	Overflow Rate (gpd/sq ft)
Primary Settling	2	750 - 1,500
Intermediate Settling	1	1,500
Final Settling	1	1,500

2. Aeration Tanks

Aeration Tank	Detention Time (hr)	Air Req'd (cu ft/gal sewage)	BOD_5 Loading (lb BOD_5/1000 sq ft/day)
1st Aeration Tank	1.2	total 1.5*	average 6.4
2nd Aeration Tank	1.2		

*The air distribution is normally 60% in 1st aeration, 40% in 2nd aeration.

The basis of design specified in the Army Engineering Manual is:[6]

1. Primary settling - 2.5 hr
2. Primary aeration - 156 sq ft surface/lb BOD_5/day (equivalent to 6.41 lb BOD_5/1000 sq ft/day)
3. Intermediate settling - 1.5 hr
4. Secondary aeration - same load as for primary aeration
5. Final settling - 2.4 hr.

The results of five contact aeration plants obtained at U.S. Army posts are plotted as the following relationships:[6]

$$E_s = 100/\{1 + 0.248\,[L_p/(At)]^{0.746}\} \quad .....(1)$$

in which

E_s = percent reduction of BOD_5 based on settled sewage (%)

L_p = BOD_5 loading (lb BOD_5/day)

A = Contact surface area (1000 sq ft)

t = aeration time (hr)

Eq (1) can be rearranged as follows:

$$\frac{L_p}{A} = (6.4824\ t)\left[\frac{100-E_s}{E_s}\right]^{1.3405} \quad ....(2)$$

Eq (2) shows the relationship between the BOD_5 loading, $\frac{L_p}{A}$, in lb BOD_5/day/1000 sq ft, and the contact aeration system treatment efficiency, E_s, in percent, under the known contact aeration time, t, in hours.

The efficiency E_s in Eqs (1) and (2) is based on primary settled sewage. In order to calculate the overall treatment efficiency, the primary settling efficiency should be included.

Assuming the primary settling efficiency is E_p percent, then the overall treatment efficiency becomes:

$$E = 100\left[1 - \left(1-\frac{E_p}{100}\right)\left(1-\frac{E_s}{100}\right)\right] \quad ....(3)$$

in which E = overall treatment efficiency (%)

E_p = primary settling efficiency (%)

E_s = contact aeration system efficiency (%)

Eq (3) can be rearranged as follows:

$$E_s = \frac{E - E_p}{1 - \frac{E_p}{100}} \quad ....(4)$$

Assuming that primary settling efficiency is 35 percent then Eq (4) becomes:

$$E_s = 1.538\ E - 53.846 \quad ....(5)$$

Substituting Eq (5) into Eq (3), the BOD_5 loading versus overall treatment efficiency can be plotted as in Figure 2.

Eq (1) can also be rearranged in the other form:

$$A = \left[\frac{L_p}{6.4824\ t}\right] \Big/ \left[\frac{100-E_s}{E_s}\right]^{1.3405} \quad ....(6)$$

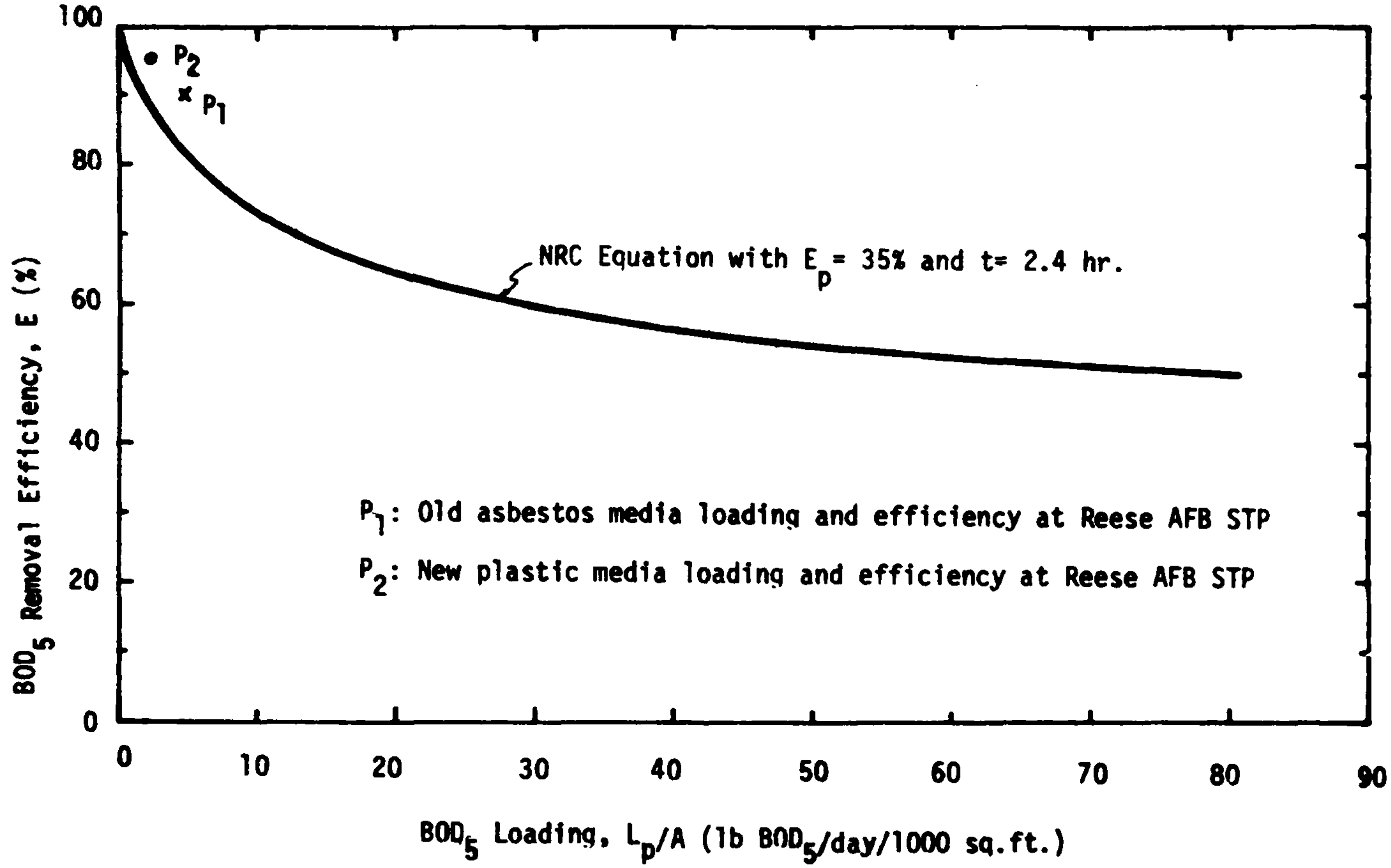

FIGURE 2. BOD_5 LOADING VS. TREATMENT EFFICIENCY

In an existing contact aeration system, if the BOD_5 loading L_p and the contact aeration time t are assumed to be constants, than Eq (6) becomes:

$$A = \frac{K}{\left[\frac{100 - E_s}{E_s}\right]^{1.3405}} \qquad \ldots\ldots\ldots\ldots\ldots\ldots(7)$$

Eq (7) shows the relationship between the contact aeration system treatment efficiency, E_s and the contact surface area, A required. If the primary settling efficiency is assumed to be 35 percent, substituting Eq (6) into Eq (7), a relationship between total BOD_5 removal efficiency and the contact surface area can be plotted as in Figure 3.

If an existing contact aeration treatment plant is upgraded by replacing the old contact media with a new media having a higher specific surface area, the treatment efficiency improvement should follow the relationship in Eq (7) or Figure 3.

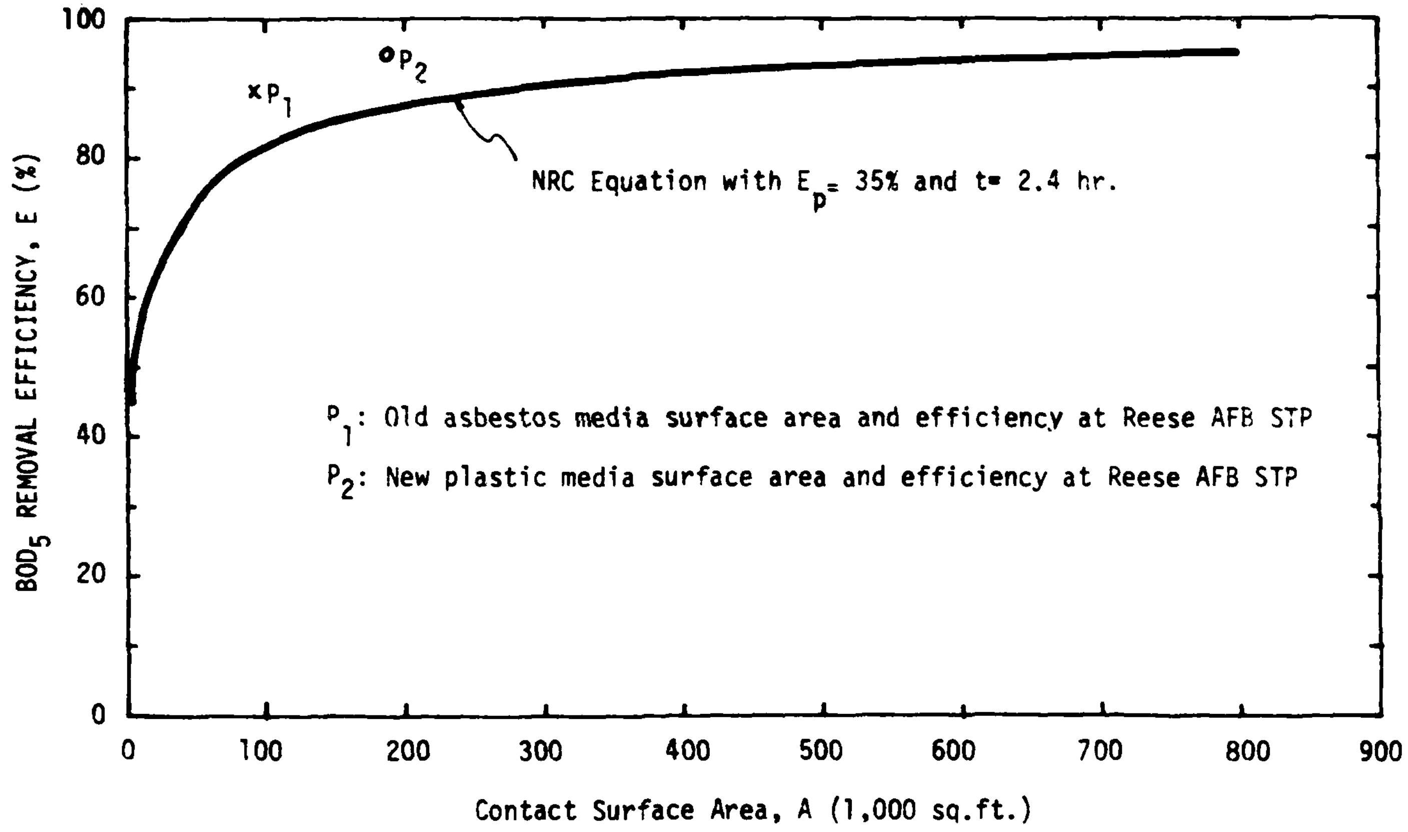

FIGURE 3. CONTACT SURFACE AREA VS. TREATMENT EFFICIENCY

IV. FINDINGS

A. Receiving Water

The irrigation lake is the only body of water that receives wastewater discharges from Reese AFB. The irrigation lake serves as the sole source of water for the golf course sprinkler irrigation system. The mean annual rainfall of about 14 inches necessitates considerable irrigation of the nine hole golf course. This water usage, in combination with evaporation and possibly percolation, prevents any surface discharge of water from the irrigation lake.

B. State Water Quality Standards and NPDES Discharge Requirements

As described above, the domestic wastewater treatment system discharges into an irrigation lake which serves as the source of irrigation for the golf course in the Reese AFB. Therefore, there is no discharge from Reese AFB to any navigable waters. Consequently, a NPDES discharge permit is not required. Irrigation of the golf course is, in reality, land treatment of domestic wastewater effluent. There are no present Federal standards or State of Texas regulations governing this type of land treatment. However as interest in land treatment is rapidly growing, however, the need and probability of regulations at the federal and/or state level will be increased.

C. Wastewater Source and Wastewater Characteristics

The source of wastewater is domestic sewage generated from the base proper and family housing. There are 2,468 military personnel assigned to the base and some of these personnel reside in the 416 family housing units. There are 12 guest housing units and a hospital with 10 beds. The number of civilian personnel employed at the base is 632. Therefore, the total population served by this treatment system is estimated to be 4,000. The water consumption in July 1979 was 718,000 gpd. The sewage flow rate during the surveying period was varied, approximately 400,000 gpd to 450,000 gpd. The sewage characteristics are tabulated in Table 2.

D. Wastewater Treatment Plant

1. Treatment Plant Description

The treatment plant is a contact aeration plant which consists of a primary settling tank, a first-stage aeration tank, an intermediate settling tank, a secondary-stage aeration tank, a final settling tank, a chlorine contact tank, two polishing lagoons, and the irrigation lake. The flow diagram is shown in Figure 1, and the treatment units descriptions are tabulated in Table 3.

The original contact media in the aeration tanks were about 1/4 in thick, 4 by 8 ft plain asbestos plates and hung vertically with approximately 1 1/2 in spaces between the plates. The contact surface area was estimated to be 16 sq ft/cu ft. The new media used are Koro-Z honeycomb plastic media made by B.F. Goodrich. The specific surface area of these media is 44 sq ft/cu ft with a void volume of 97 percent. The module dimensions are 2 ft X 2 ft X 4 ft.

Table 2: Reese AFB Raw Sewage Characteristics

Parameter	Average Concentration (mg/ℓ except noted)	Remarks
BOD_5	186	1978-1979
SS	181	
NH_3-N	23.5	Jun-Aug 1979 Avg.
TKN	27.4	
NO_3-N	0.3	
PO_4 as P	7.6	
pH	6.5 - 7.5 (unit)	
LAS	1.2	
Phenol	35 μg/ℓ	

Table 3. Description of the Reese AFB TX Wastewater Treatment Units

Parameter / Unit	Primary Settling Tank	First Aeration Tank	Intermediate Settling Tank	Secondary Aeration Tank	Final Settling Tank	Chlorination Tank
Dimensions ($W^{ft}xL^{ft}xWD^{ft}$)	12.25x67x8	12x33x8*	12x38x8	10x33x8*	10.25x69x8	7.4x10.25x8
Volume (gal)	49,100	23,700*	27,290	19,750*	42,320	4,540
Detention Time** (hr.)	2.8	1.3	1.5	1.1	2.4	0.256 (15.4 min)
Surface Overflow Rate** (gpd/sq. ft.)	518	--	932	--	600	--
Contact Surface Area (sq. ft.)	--	101,380 (50,690)***	-- --	84,480 (42,240)***	-- --	-- --

* Contact media dimensions or volume
** Based on the flow rate of 425,000 gpd
*** The original contact media before replacement

The treatment plant has a chlorination tank downstream of the final settling tank. The chlorination operation, however, is no longer applied at this tank. Chlorine is added at the irrigation line only when the water in the irrigation lake is pumping to the golf course for spray irrigation.

2. Treatment Plant Efficiencies

The treatment efficiencies of the treatment plant with the asbestos plates (old media) and with the new honeycomb plastic media (new media) are listed in Table 4.

a. BOD_5 Removal

The BOD_5 removal efficiency was 90 percent when the original asbestos plates were in use. The BOD_5 loading was 4.62 lb BOD_5/day/1000 sq ft. The present BOD_5 removal efficiency is 95 percent after the original asbestos plates were replaced with honeycomb plastic media. The BOD_5 loading with this new media is 2.31 lb BOD_5/day/1000 sq ft.

The primary settling removal efficiency at Reese AFB is 35 percent and the contact aeration detention time is 2.4 hr. If these two known values are incorporated into the NRC equation for the contact aeration process, Eq (1), the expected treatment efficiency at Reese AFB sewage treatment plant would be as shown in Figures 2 and 3. However, the actual treatment efficiency at Reese, as shown in Figures 2 and 3 with P_1 and P_2, is much better than what the NRC equation predicted.

Figures 2 and 3 indicate that the five contact aeration plants used for the NRC equation derivation[6] may have been improperly designed and/or operated, or may have had a less biodegradable wastewater. Therefore, the NRC equation might have been misleading regarding the contact aeration process, so that the continued application of this process was discouraged. At least, this process was "less desirable" for use in military camps than trickling filters as recommended by the NRC committee.

b. Nitrification

There was no significant ammonia nitrogen removal during the first two months after the new plastic media were installed. The ammonia nitrogen removal capability, however, started to build up afterwards. The present ammonia nitrogen removal efficiency is up to 48 percent. This removal efficiency is still increasing, but at a much slower rate. Unfortunately, the nitrogen removal capability of the system before media replacement had not been analyzed. The only nitrogen data available are the analyses performed in November 1974 which indicated that there was no nitrification at all.[1]

The major portion of the ammonia removal at this plant is in the secondary aeration tank. The ammonia nitrogen loading rate is 0.446 lb NH_3-N/day/1000 sq ft, and the removal rate is 0.077 lb NH_3-N/day/1000 sq ft in the first aeration tank and 0.373 lb NH_3-N/day/1000 sq ft in the secondary aeration tank. Since there is no previous nitrification information available for the contact aeration process, except the one study where two contact aeration systems were used for nitrification, as mentioned before,[8] it is hard to say

Table 4. Treatment Efficiencies at Reese AFB STP January 1978-August 1979

Parameter (mg/ℓ)	Raw Wastewater	Primary Effluent	Intermediate Effluent		Final Effluent	
			Old Media	New Media	Old Media	New Media
BOD_5	186	121	--	40	18	9
COD	234	141	--	70	--	30
SS	181	110	--	33	14	6
NH_3-N	23.5	23.4	--	21.2	--	12.3*
TKN	28.4	27.6	--	23.3	--	15.3*
LAS	1.7	--	—	--	--	0.3*

* July-August 1979 data

that the removal rate detected at the present time at Reese AFB is the limitation of the contact aeration system. The conventional activated sludge system with even a longer aeration time, e.g., 4-8 hr, cannot achieve much nitrification at all. Therefore, this contact aeration system can out-perform conventional activated sludge, not only obtaining a very high BOD_5 removal but also achieving a substantial degree of nitrification.

c. Suspended Solids Removal

The suspended solids (SS) removal efficiency was improved from the original 92 percent up to 97 percent after media replacement. The present effluent SS concentration is 6 mg/ℓ, which is excellent for a secondary treatment system.

d. Foaming Problem

The plant had, at times, suffered from a foaming problem in the aeration tanks. After a spray water line was installed at the south halves of the aeration tanks, the foaming problem was alleviated in these halves of the tanks. The north halves of the tanks, however, are still occasionally suffering from this problem. Fortunately, the foam is always confined in the aeration tanks and does not discharge into the final settling tank or the final effluent. The addition of another spray water line to the north halves of the aeration tanks will reduce the foaming problem.

e. Phenol Removal

The phenol content of the wastewater was also analyzed. The raw wastewater phenol concentrations varied from 0 μg/ℓ to 264 μg/ℓ in the June-July 1979 period. The average phenol concentration was approximately 35 mg/ℓ. Since this concentration is low and the fixed film biological system can normally tolerate a higher phenol concentrate than the suspended growth system,[6] there was no adverse effect observed due to this phenol content. The phenol is degraded in the biological treatment stage and only a trace amount is discharged in the final effluent.

f. Dissolved Oxygen (D.O.)

The D.O. content of the final effluent was normally 0 mg/ℓ, and occasionally 2-4 mg/ℓ, before the old air diffusers were replaced. The partially clogged old air diffusers were replaced with the Activator Hydro-Chek Air Diffusers, Model 37. The final effluent D.O. has increased to above 3-4 mg/ℓ most of the time.

V. CONCLUSIONS AND RECOMMENDATIONS

The treatment plant performance is excellent since the contact media and the air diffusers were replaced. The upgraded plant can achieve not only 95 percent BOD removal and 97 percent SS removal, but also achieves about 50 percent nitrification and provides a final effluent D.O. of 3-4 mg/ℓ most of the time. A trickling filter system or an activated sludge system could only achieve this kind of BOD_5 removal and SS removal with good design and under carefully controlled situations. The nitrification, however, is hardly achievable in a secondary trickling filter system or a secondary conventional activated sludge system under the comparable design criteria. The contact aeration system is also easier to operate because there is no need for recirculation or sludge return. Based on operating experience over the past years and in the past nine months since the new media were installed, and contrary to the NRC committee report[6], the system requires very little maintenance and there are no odor problems.

However, there are two questions unanswered at this time. The question are: how critically the new installed honeycomb media, which have a smaller and also zigzag void, are subject to clogging, and how easily this clogging can be dislodged if the clogging does happen? The honeycomb media have been in service for almost eight months in this plant, and there is no sign of clogging or uneven distribution of wastewater flow pattern at this time. This does not mean, however, that the possibility of clogging in the new media will not increase with time, especially if floating material and/or stringing material are allowed to flow into the aeration tanks. Therefore, the pretreatment, such as screening and comminuting, should be carefully operated. The possible excess biofilm growth in the contact media should also be checked at all times so that the excess growth can be removed in an artificial way, such as a high pressure water jet.

The phase out of the lagoons is being considered due to the maintenance problems in dredging and weed control. The sewage treatment plant, however, has only one tank in each unit process. If the lagoons are phased out, and the treatment plant has to be shut down due to regular maintenance or mechanical failures, the raw sewage will be by-passed to the irrigation lake. In this situation, raw sewage will pollute the irrigation lake and pose a threat to the aquatic life/wildlife which reside in the irrigation lake. Therefore, consideration should be given to the environmental impact if the lagoons are phased out.

Other recommendations are as follows:

Install a flow meter/totalizer with recorder, so that the plant flow can be measured for treatment plant process control and operation. Plant wastewater flow can also be recorded for future reference.

Resume the chlorination practice at the treatment plant chlorination tank, at least in the summer to insure that no health hazard will be created due to the discharge of unchlorinated effluent.

Install an additional spray water line at the north halves of the aeration tanks to alleviate the foaming problem in the aeration tanks.

REFERENCES

1. Engineering and Biological Evaluation of Wastewater Treatment Practices at Reese AFB TX, USAF Environmental Health Laboratory, Kelly AFB, Texas. EHL(K) 76-3, April 1976.

2. Buswell, A.M. and E.L. Pearson, "The Nidus (Nest) Rack, a Modern Development of the Travis Colloider", Sew Works Jour. 1(2):187-195, January 1929.

3. Lackey, J.B., and R.M. Dixon, "Some Biological Aspects of the Hays Process of Sewage Treatment" Sew Works Jour. (Vol 15) 15:1139-1153, November 1943.

4. Wilford, J., and T.P. Colon, "Contact Aeration Sewage Treatment Plants in New Jersey." Sew. and Indus. Works, 29(8):845-855, August 1957.

5. Steel, E.W., Water Supply and Sewage, McGraw-Hill Book Co., New York, 1960.

6. Fair, G.M., R.E. Fuhrman, C.C. Ruchhoft, H.A. Thomas, and F.W. Mohlman, "Sewage Treatment at Military Installation - Summary and Conclusions," Sew Works Jour. 20(1):84-87, January 1948.

7. Kato, K. and Y. Sekikawa, "Fixed Activated Sludge Process for Industrial Waste Treatment", Proc of the 22nd Ind. Waste Conf., May 2-4, 1967. Purdue Univ, pp 926-949.

8. Abd-El-Bary, M.F., and M.J. Eways, "Biological Nitrification in Contact Aeration System", Water and Sewage Works. 124(6):91-93, June 1977.

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